Advanced Distributed Multimedia Data Analysis and Display Technology: The Sunrise Project and it's application to healthcare and manufacturing

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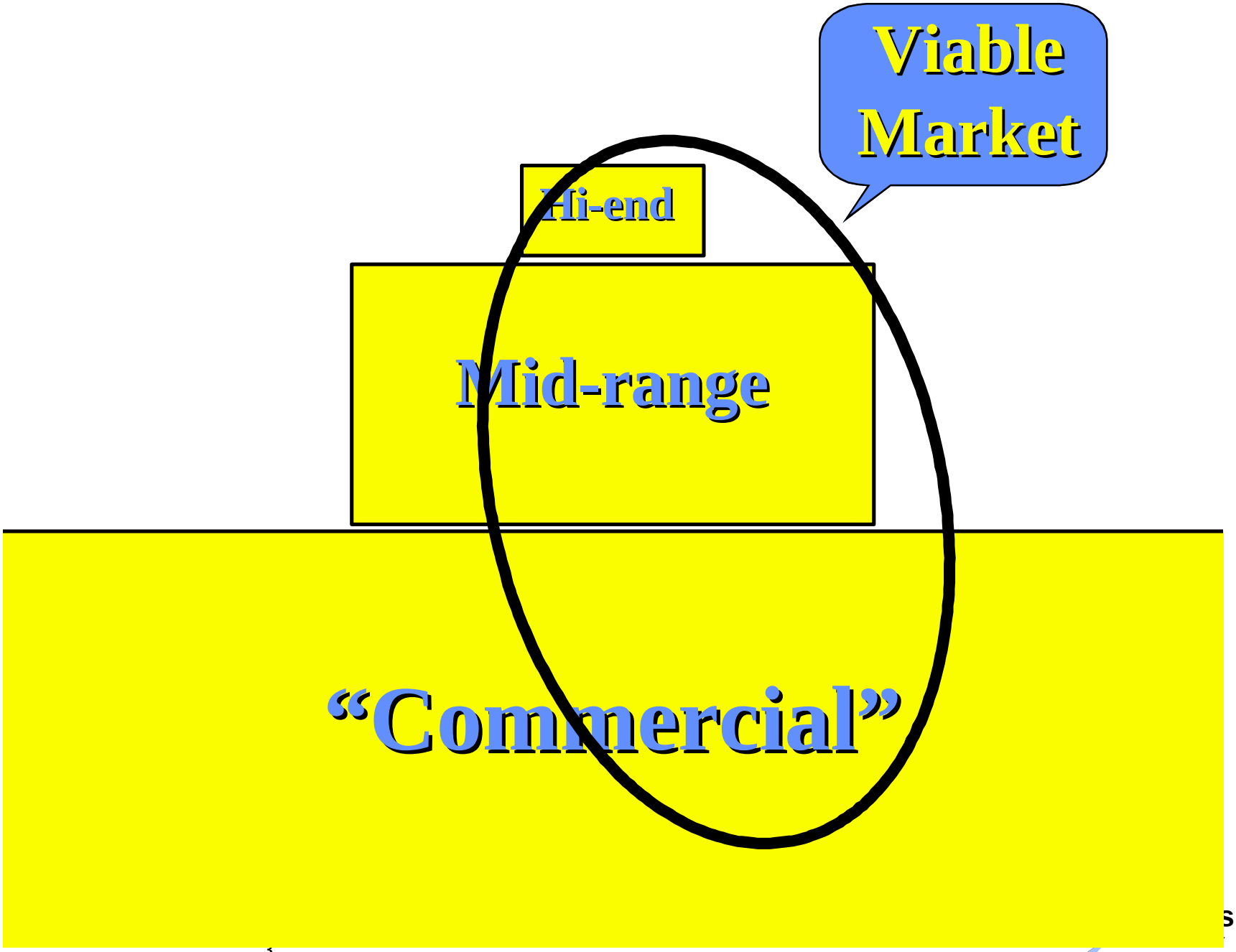
Barriers to High Performance Computing in Manufacturing

- HPC is traditionally what Los Alamos has been about in computing
- HPC is becoming a niche market in computing with the growth of commercial computing market
- HPC is difficult to use
- Total solution of a problem is the bottom line
- We are attempting to marry the desktop to HPC in a transparent manner to overcome some of these barriers: Sunrise


Viable Market
Hi-end
Mid-range
"Commercial"

Advanced Computing

- HPC market, Commercial market
- Industry overpopulated & fragile
- No common development target
- Reliability, maturity still lacking
- Workstations inexorably gaining
- Computational science less important

Little diffusion of software, capability
Still critical for success

Environment of the Future

Capable

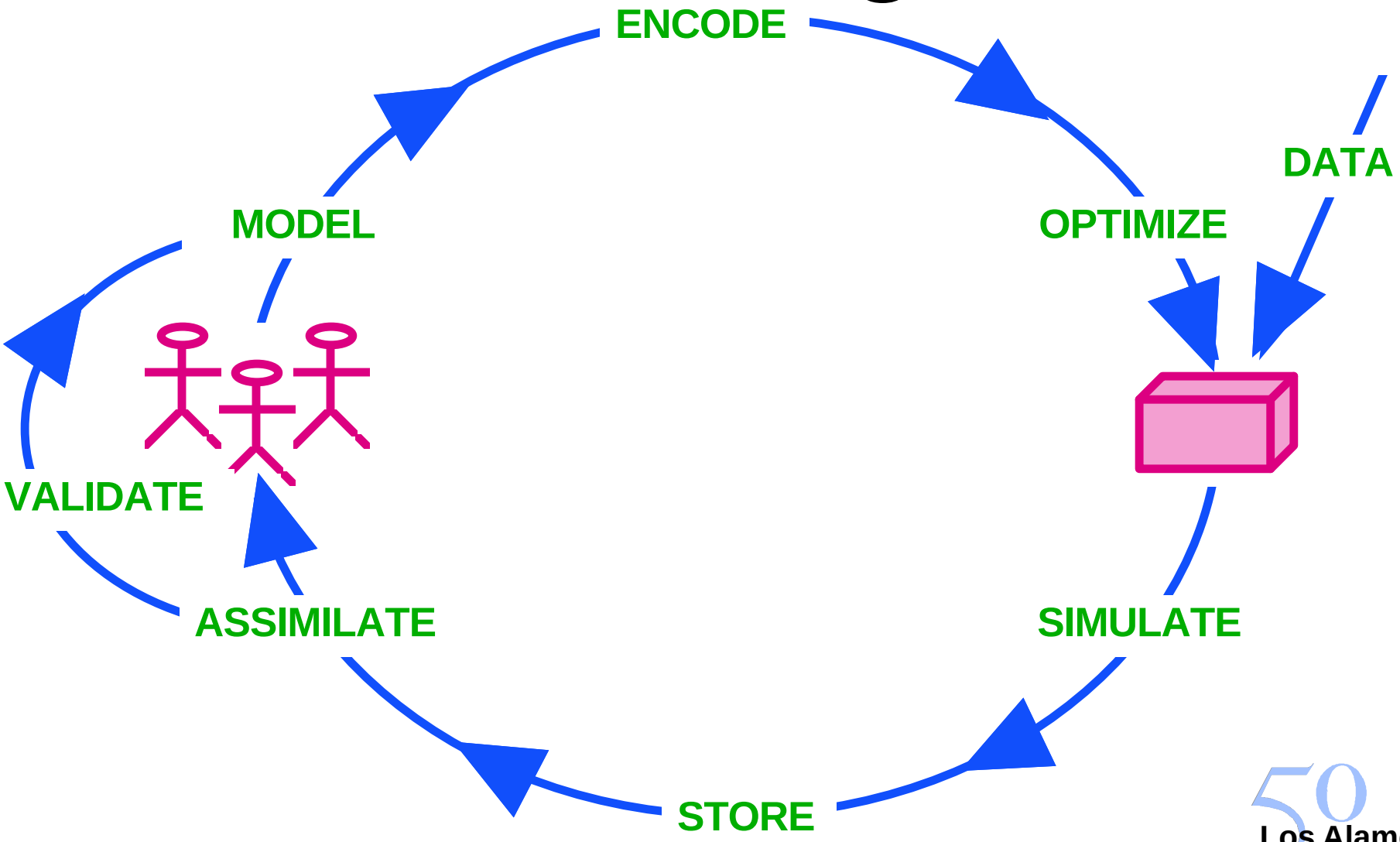
Agile

Universal

Scaleable

Egalitarian

Problem Solving Process



Sunrise: an Integrated Approach to the NII

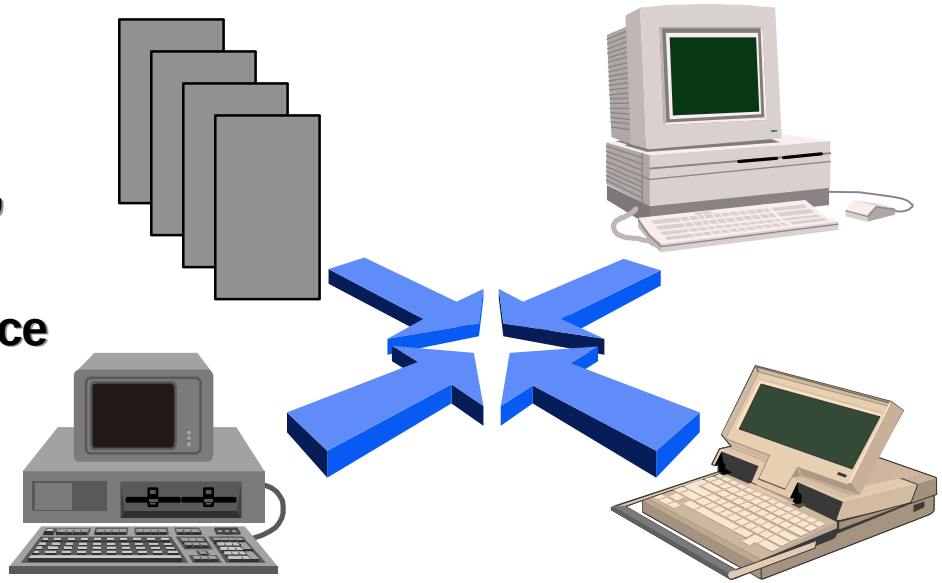
- **Need: Scaleable, extensible architecture for the National Information Infrastructure which works for industry**
- **Objectives:**
  - **Develop common information-enabling tools for advanced scientific research and its application to industry**
  - **Enhance the capabilities of important research programs at the Laboratory**
  - **Define a new way of collaboration between computer science, and industrially relevant research**

Sunrise: An Integrated Approach to the NII

- Build on HPCC strengths at LANL
  - Develop HPCC as a commodity service
- Use application suite to define infrastructure
- Design reusable components that span many disciplines:
  - e.g., CFD simulation to telemedicine
  - data-mining is common to wide variety of problems
- Use industrial standard, interoperable components wherever possible
- Build on network which provides high-bandwidth, multimedia for the future
- Live with existing bandwidth when necessary

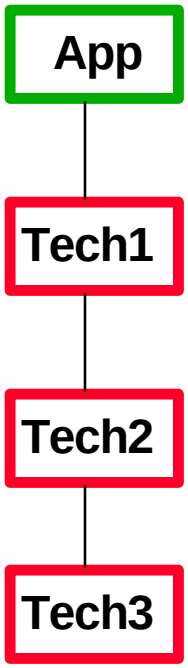
The Problem of Integrating Applications

- ***Application Integration*** **and** ***Distributed Processing*** **are the same thing:**
- **Constructing information-sharing distributed systems from diverse sources:**
  - ❑ **heterogeneous,**
  - ❑ **networked,**
  - ❑ **physically disparate,**
  - ❑ **multi-vendor.**
  - ❑ **disparate performance**



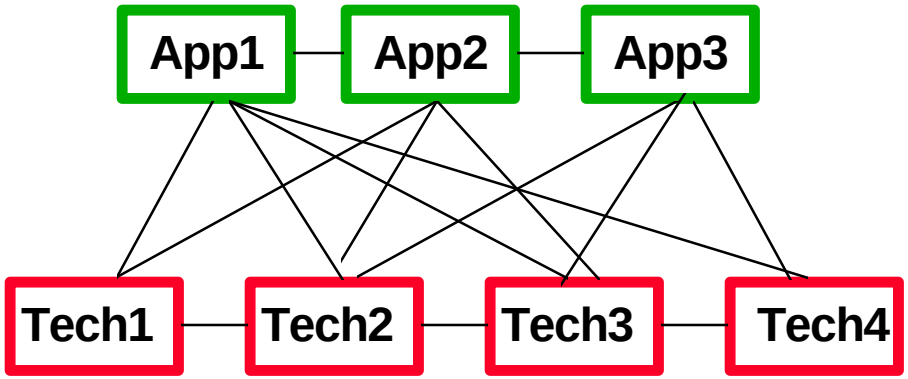
Sunrise Approach

Vertical Integration



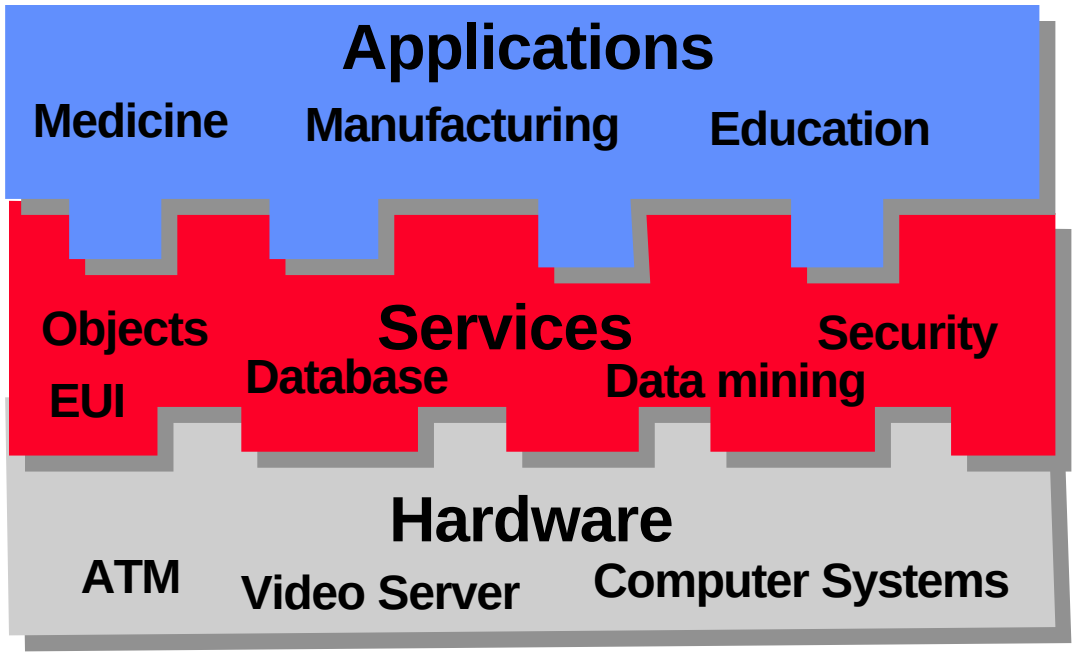
- Efficient for given domain
- Not always scaleable

Horizontal Integration



- Common tools identifed
- Infrastructure clearly delineated
- Scaleable solutions

Sunrise uses an Integrated, Layered structure



Integrated Applications

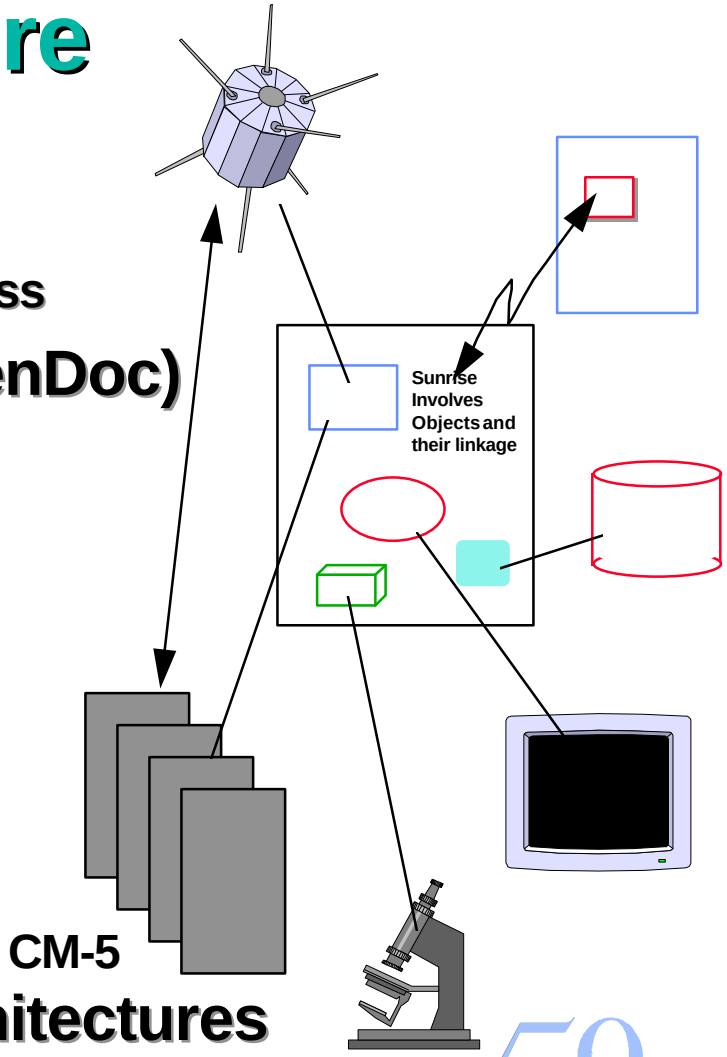
- Telemedicine
- Materials modeling analysis
- Manufacturing technologies
- Engineering design tools
- Environmental Management

Integration Infrastructure

- Distributed Object Computing
- User Interface and Telecollaboration
- Data Analysis and Visualization
- Data Mining
- ATM Networking
- Security

Reusable, Extensible Infrastructure

- Distributed Object System
  - Dynamic, hierarchical, desktop access
- Document interface (e.g., OpenDoc)
  - Nested, remote, objects
  - Extensible
  - Heterogeneous platform support
  - Can link to scientific application
- Multimedia support (ATM)
- Security for each object
- Telecollaboration
- Spans multiple hardware architectures



Distributed Object Development Environment

- Portable Object Foundation Classes
- Implemented on workstations, parallel machines, clusters, and vector supercomputers (operational on Sun, Cluster, CM-5, T3D)
- Efficient, portable IO Framework
  - Data written on CM-5 SDA read on Cray, workstation
  - Transparent archiving
- Application specific objects built on top of these: Particle simulation, teleradiology, Clustering algorithms
- Analysis and visualization classes (under development)

User Interface and Telecollaboration

- Need for a media-rich flexible user interface that can provide the information in an intuitive and extensible manner
- Support for video, sound, and distributed data sources required
- Gain Momentum has been used because of its flexible, object-oriented support of multimedia.
- An executive user interface for computerized patient records has been developed
- Logbook capability is in development
- Wide World Web used for project communication

Security

- Goal: Provide capability for authentication and authorization to view distributed data
- Secure data at object level, allow policy to drive security deployment
- Developed Kerberos-like public-key based key and ticket server system for use with CORBA
- Developed a scheme to secure remote C++ method calls in CORBA applications

Data Mining

- Large Data sets need computational assistance for analysis
- General concept extraction techniques including
  - image comparison and matching
  - multi-dimensional cluster analysis
  - wavelet transform for variable granularity display
  - multi-dimensional database navigation
- Deliver these technologies in a usable, scaleable environment

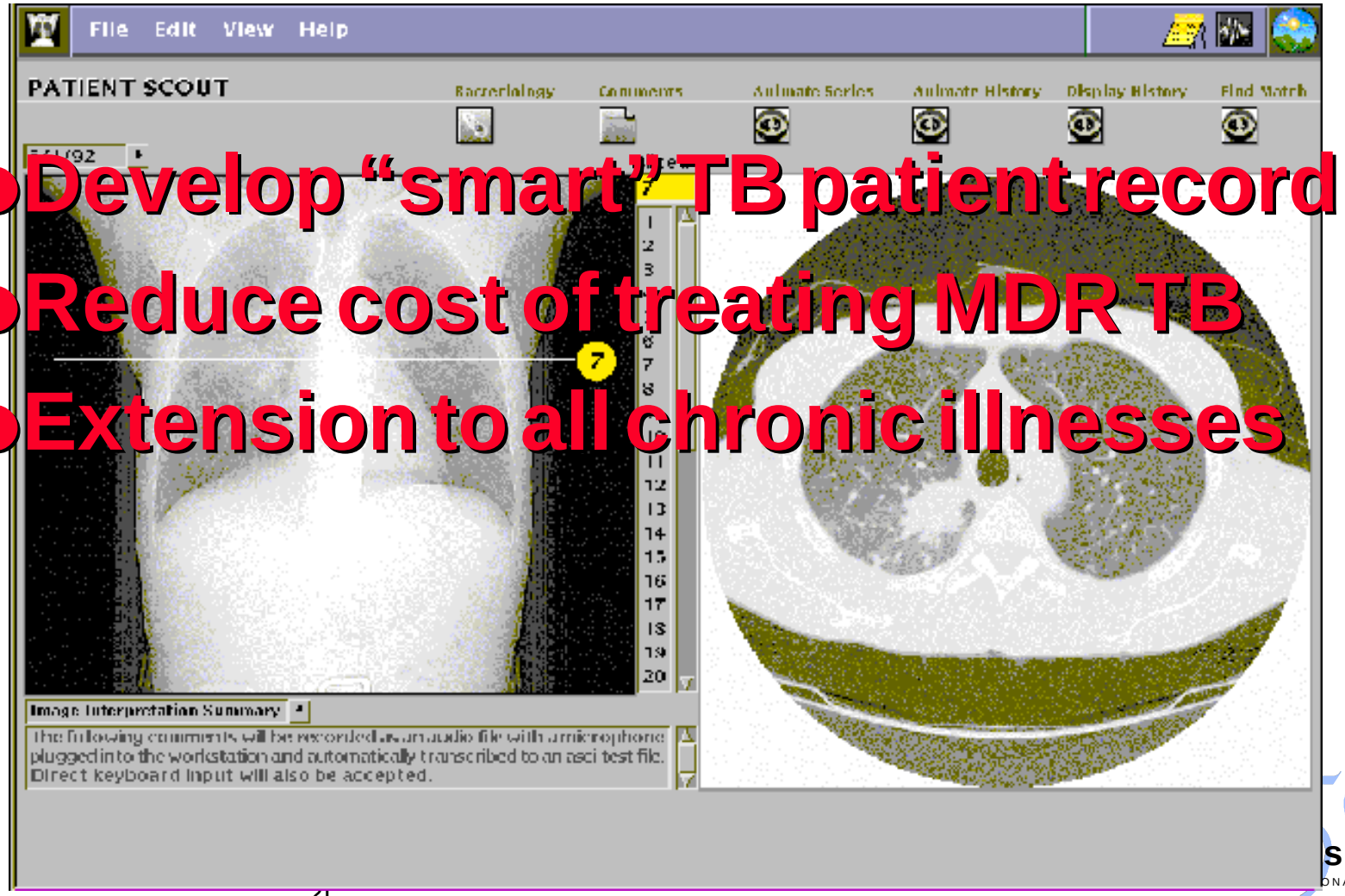
Medical Information

- The National Information Infrastructure (NII) will have a profound effect on the way in which medical data is utilized.
- A patient's medical history be immediately available to a physician anywhere in the country within seconds, and this history will contain
  - text (physician notes from every office visit),
  - numerical data (height, weight, blood pressure),
  - digitally recorded signals (erratic heart sounds, EKG traces),
  - and digital imagery (photographs, x-rays, MRI scans).

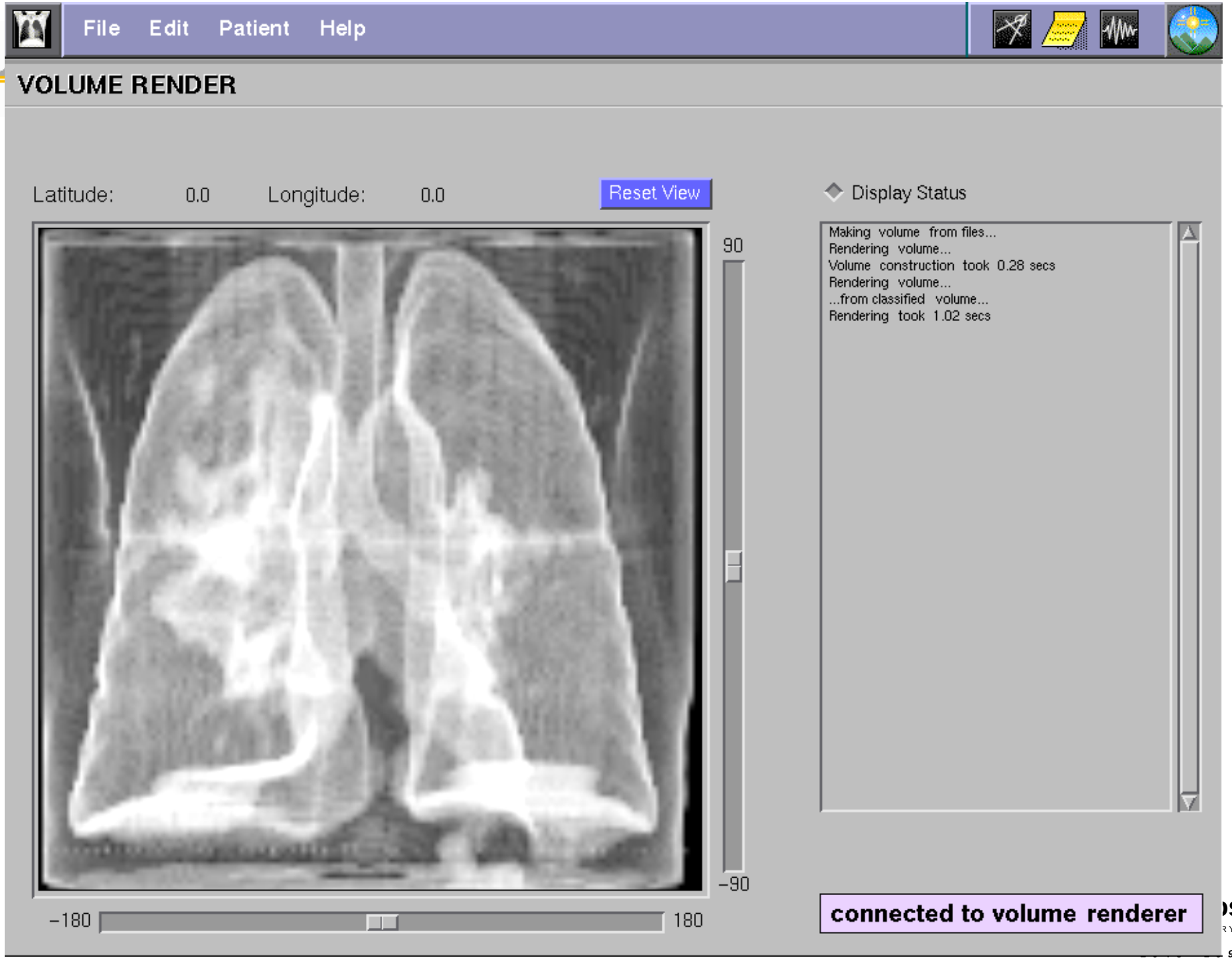
TeleMed

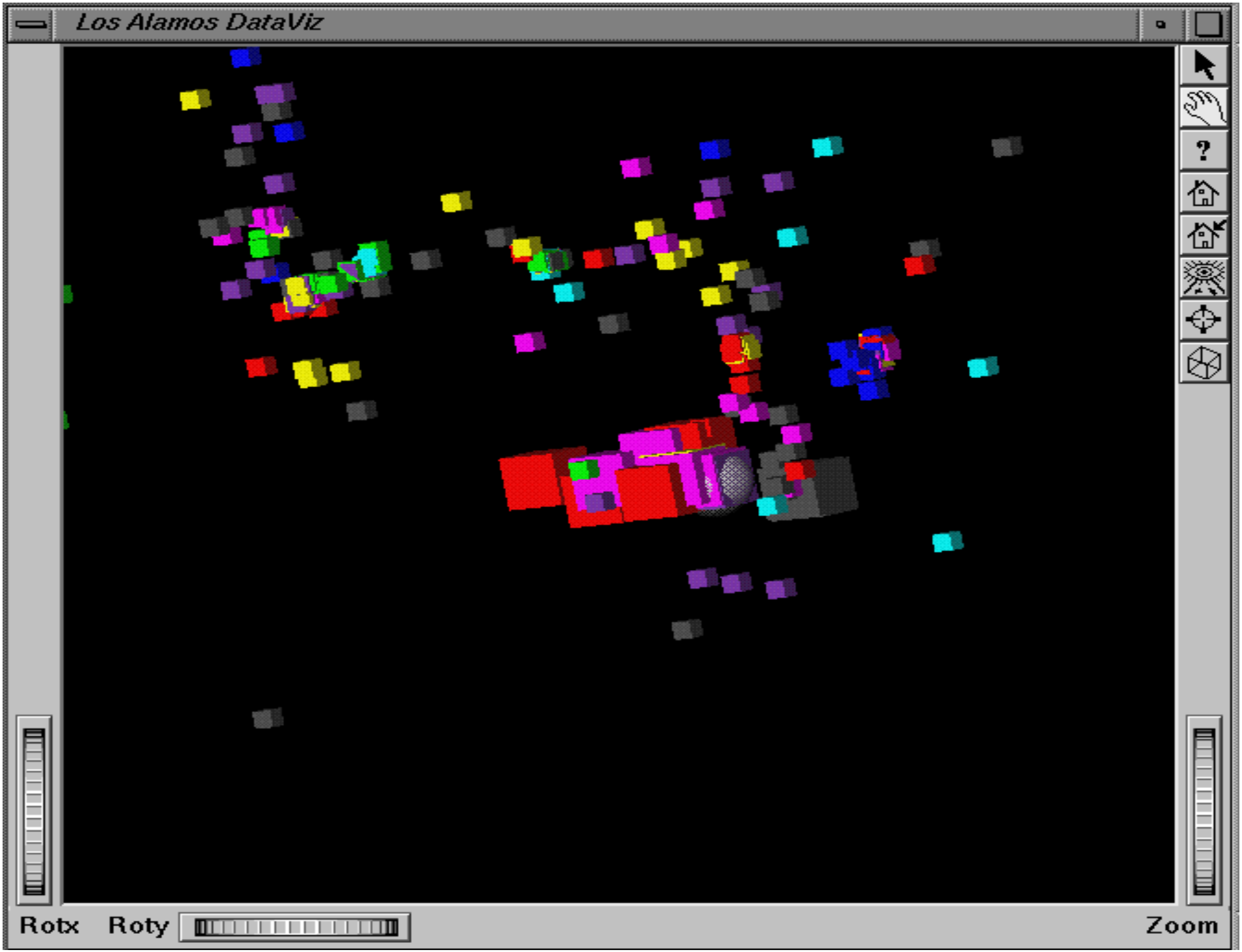
- We have developed a prototype software environment for a physician
  - relevant information is available and easily manipulated.
  - Displays and analyze imagery,
  - manage patient records,
  - provide easy data entry,
- Transparent access to information located anywhere on the massive *information superhighway* will give doctors great flexibility in their work

TeleMed Applies Advanced NII Technology to HealthCare

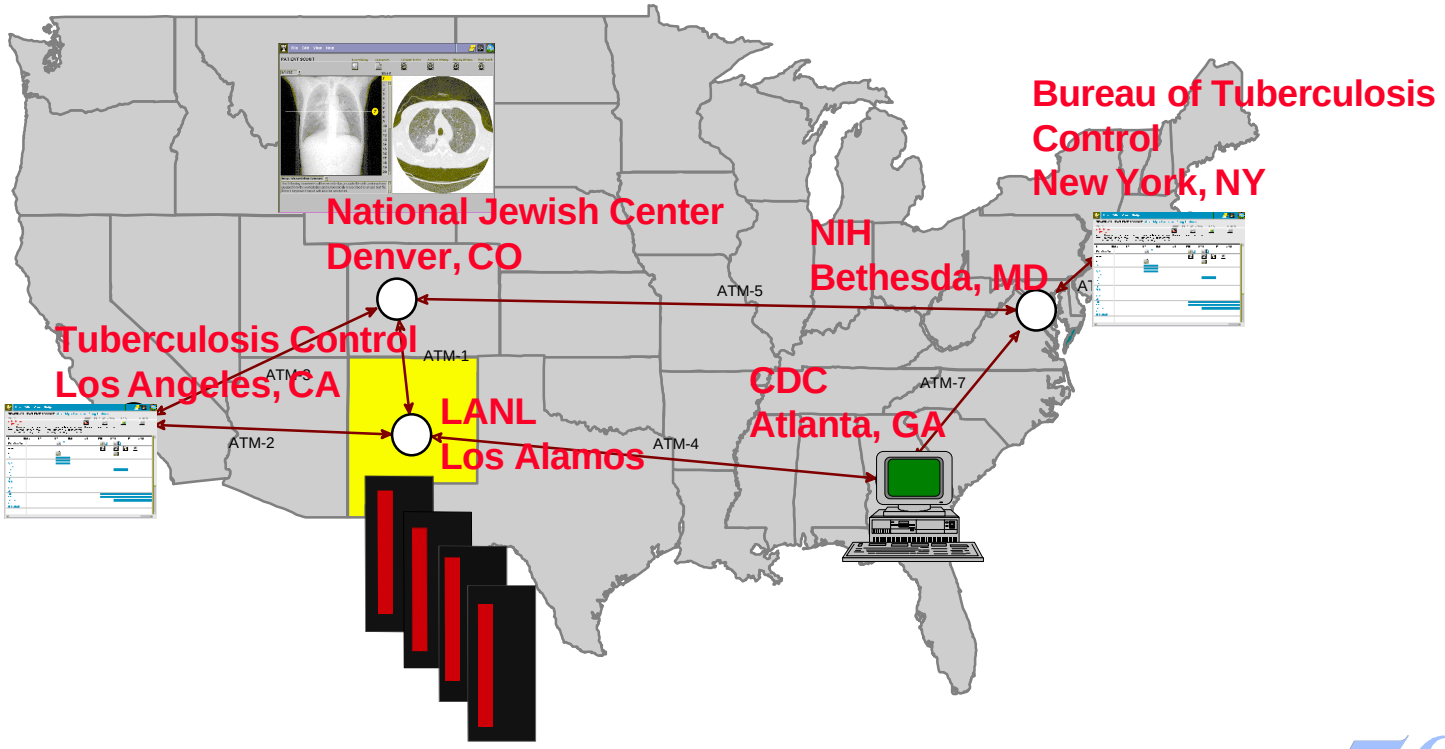


- Develop "smart" TB patient record
- Reduce cost of treating MDR TB
- Extension to all chronic illnesses


File
Edit
Patient
Help
VOLUME RENDER
Latitude:
0.0
Longitude:
0.0
Reset View
Display Status
Making volume from files...
Rendering volume...
Volume construction took 0.28 secs
Rendering volume...
...from classified volume...
Rendering took 1.02 secs
90
-90
-180
180
connected to volume renderer


Los Alamos DataViz
?
Rotx
Roty
Zoom

Sunrise TeleMed Network



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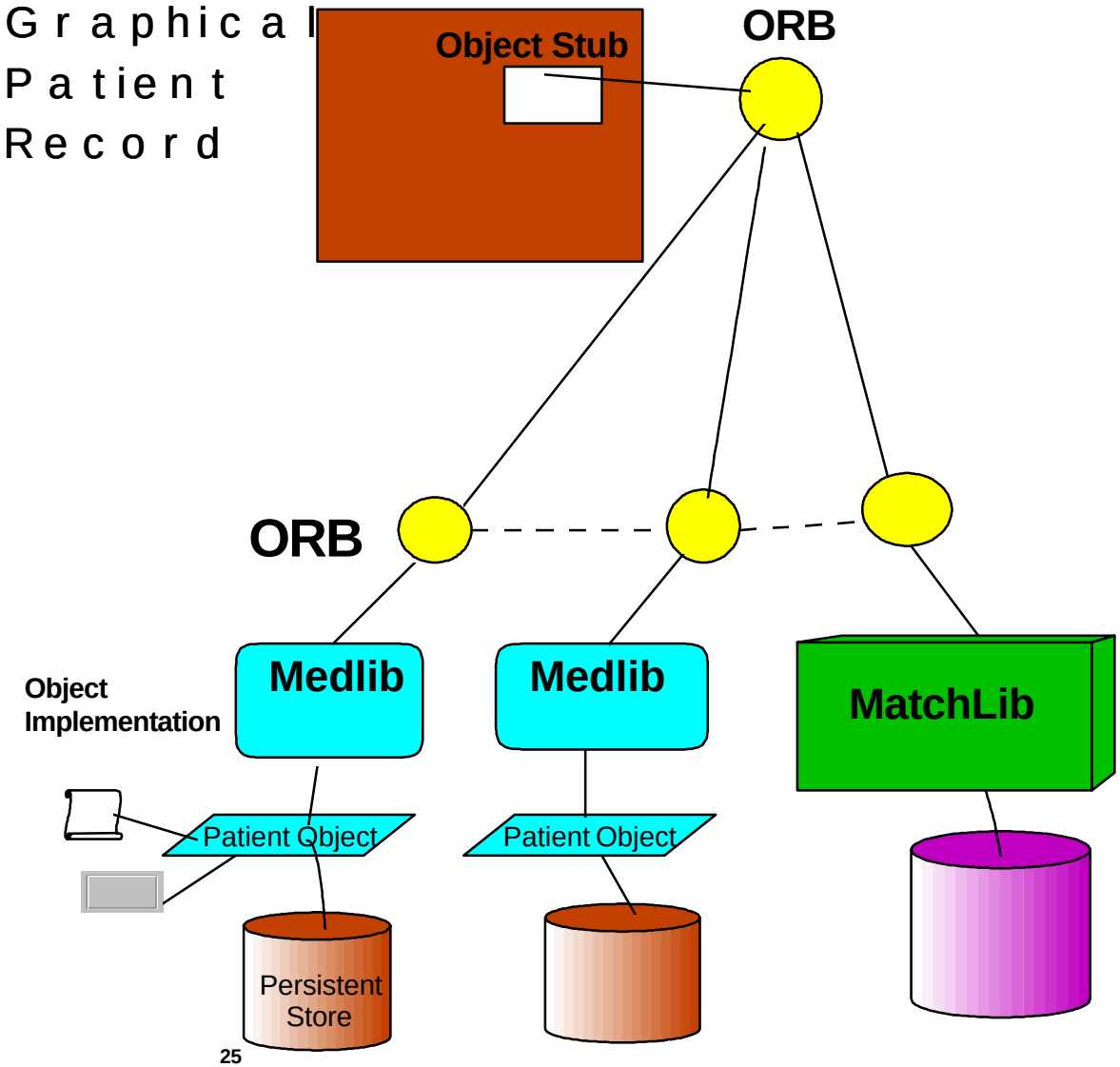
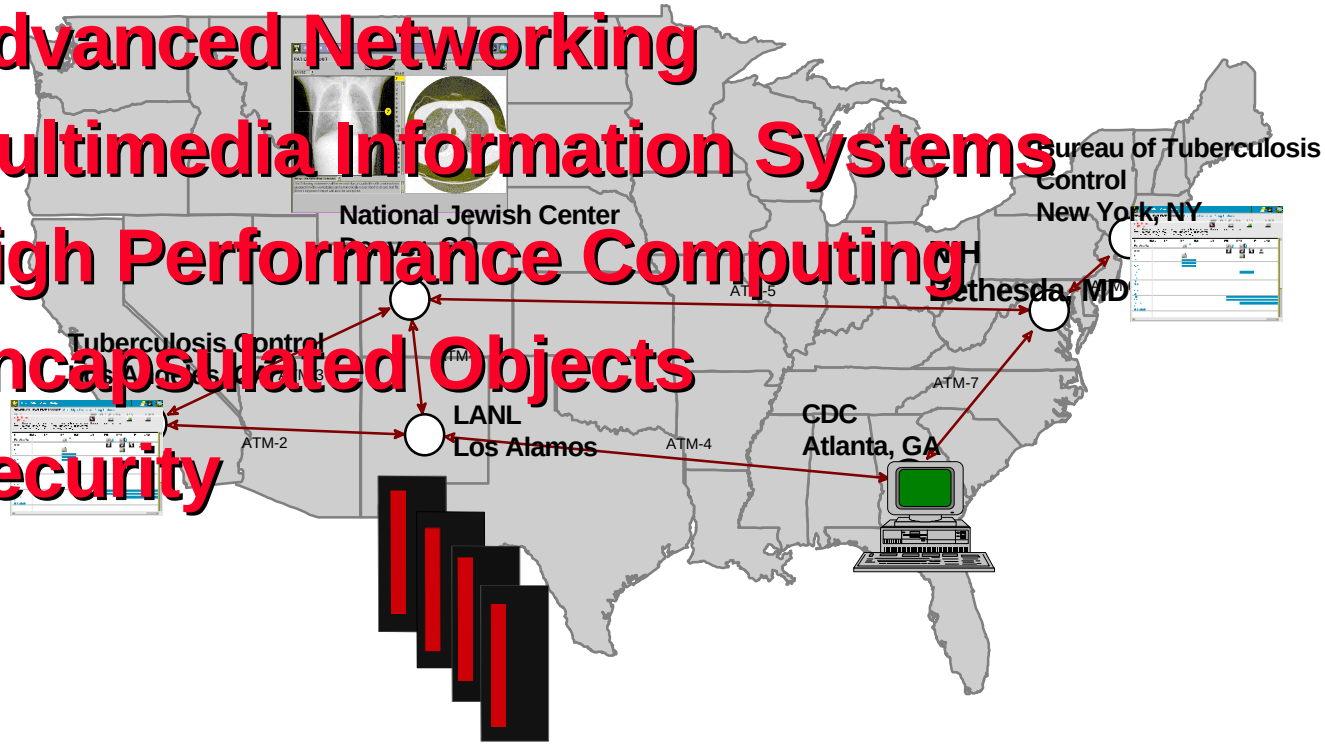
TeleMed Architecture



TeleMed Network Builds on Advanced NII Technologies

- Distributed Computing
- Advanced Networking
- Multimedia Information Systems
- High Performance Computing
- Encapsulated Objects
- Security

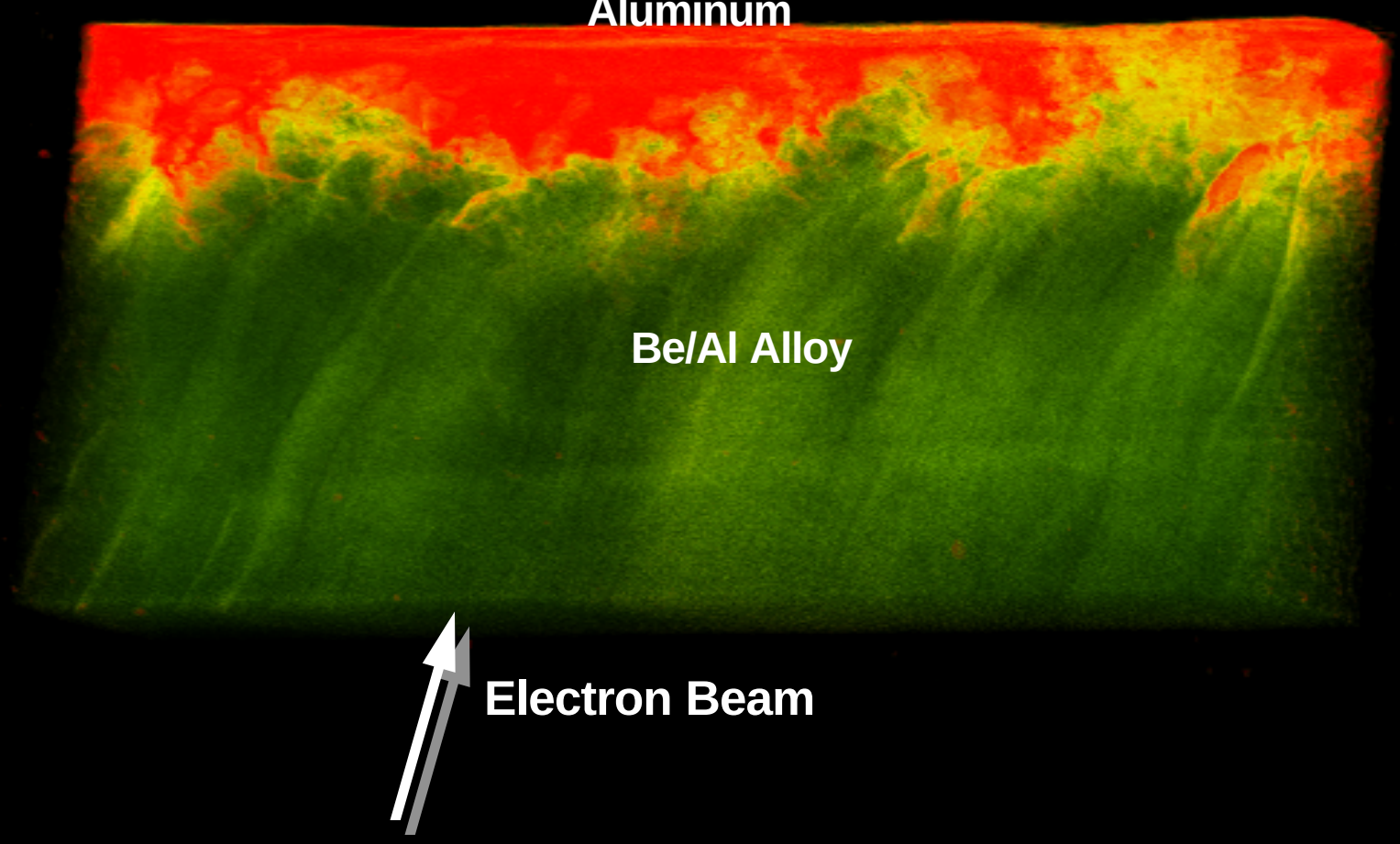


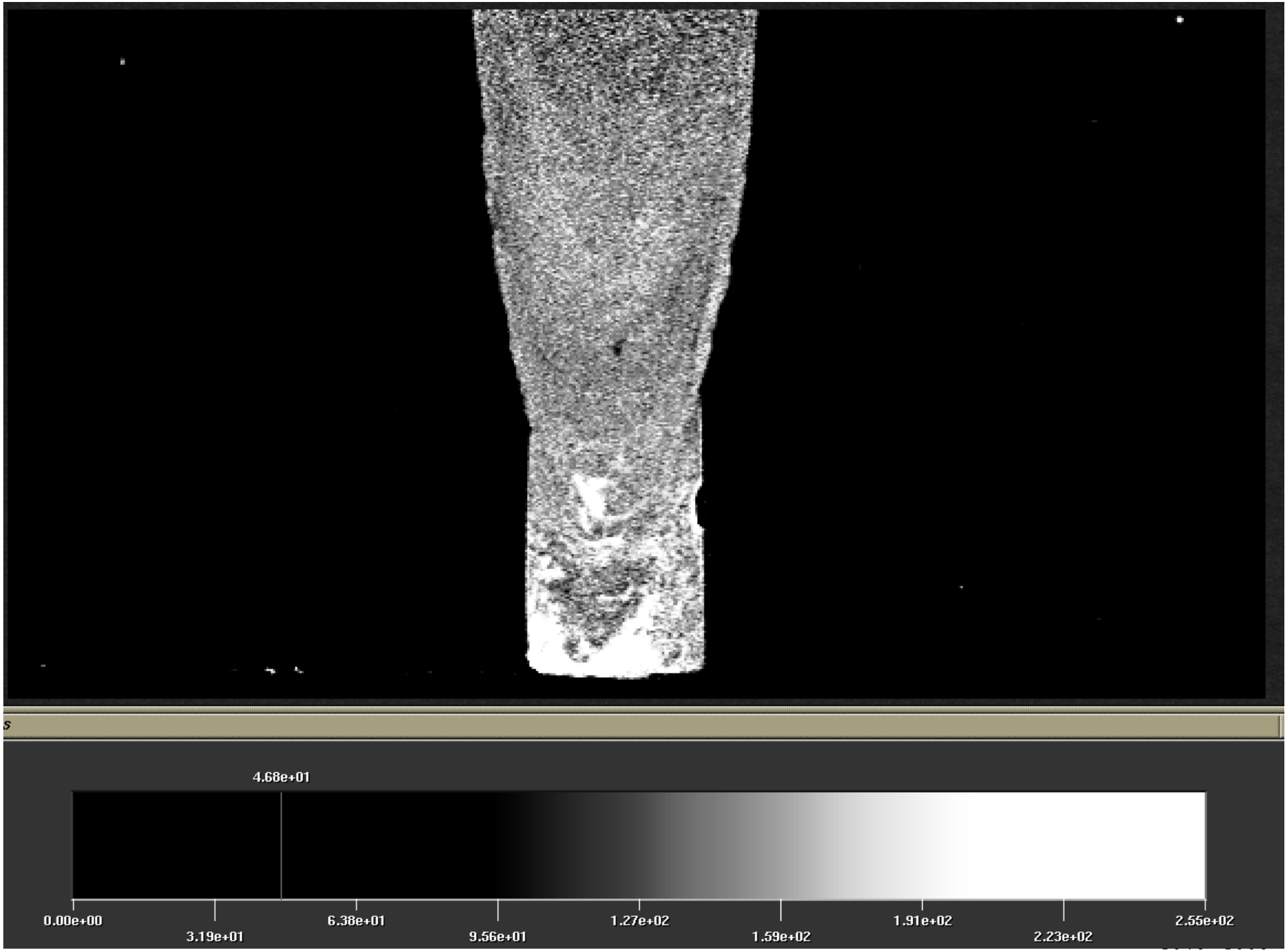
Los Alamos NATIONAL LABORATORY 1943 - 1993

Sunrise and Manufacturing

- **Many problems are the same as in medicine:**
  - **We must keep track of large amounts of information selectively and intelligently for a system over time**
  - **We must be able to determine relationships between textual, image, and other engineering data**
- **We are beginning support for microstructure of materials used in manufacturing:**
  - **Characterize structures of welds created with electron beams and laser beams, using x-ray tomography, e.g.**
  - **Characterize structures of a variety of data generated by SEM and TEM instruments**
- **Surveillance of full engineering systems to determine history and current usefulness**

Beryllium/Aluminum Weld

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0.00e+00
3.19e+01
6.38e+01
9.56e+01
1.27e+02
1.59e+02
1.91e+02
2.23e+02
2.55e+02

Emphasize Technology Reuse

- **Image Browsing tools**
  - Feature extraction works for materials, medical images, financial data, transportation networks
  - Extension of feature extraction to other domains
- **Standardized base objects**
  - Common elements such as signatures, image, embeddability
  - Portable across systems and storage technologies
- **Navigation tools**
  - Location finding, object name resolution, network display
  - Log books, secure time stamps
- **Digital video might be computer output or instrument output**
  - Data fusion combines different types of data

Sunrise Futures

- Add embedded video teleconferenceing software for tele-collaboration so that data can be annotated in a “shared” manner.
  - Store video data with other data
- OpenAPI for connect a variety of additional analysis tools.
- Extended query capability.
- Deploy full software in an engineering environment.

Information Infrastructure will Change Manufacturing Methodology

- Electronic Commerce (EDI)
- Support virtual corporations with distributed assets
  - Provide access to distributed databases
  - Data Mining on corporate knowledge
- Enhance ability to select and discriminate between advanced manufacturing technologies
- Better understand collections of integrated systems and how they function
  - Relate as-designed to as-built
  - Facilitate necessary retrofits, etc. only as needed